Time: 1 hour 30 minutes

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulas stored in them.

Instructions to Candidates

Write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Core Mathematics C4), the paper reference (6666), your surname, initials and signature.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
There are 8 questions in this question paper. The total mark for this paper is 75.
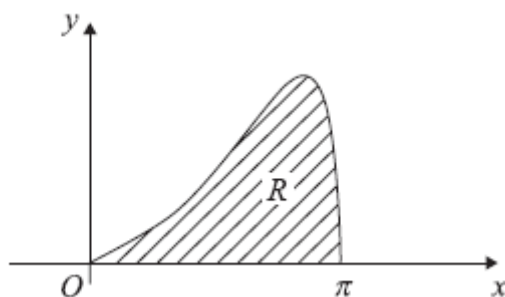
Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

Suggested grade boundaries for this paper:

A*	A	B	C	D	E
67	59	52	47	41	35

1.

Figure 1

The curve shown in Figure 1 has equation $e^x\sqrt{(\sin x)}$, $0 \le x \le \pi$. The finite region R bounded by the curve and the x-axis is shown shaded in Figure 1.

(*a*) Copy and complete the table below with the values of y corresponding to $x = \dfrac{\pi}{4}$ and $x = \dfrac{\pi}{2}$, giving your answers to 5 decimal places.

x	0	$\dfrac{\pi}{4}$	$\dfrac{\pi}{2}$	$\dfrac{3\pi}{4}$	π
y	0			8.87207	0

(2)

(*b*) Use the trapezium rule, with all the values in the completed table, to obtain an estimate for the area of the region R. Give your answer to 4 decimal places.

(4)

January 2008

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2. The curve C has equation

$$3^{x-1} + xy - y^2 + 5 = 0$$

Show that $\dfrac{dy}{dx}$ at the point $(1, 3)$ on the curve C can be written in the form $\dfrac{1}{\lambda}\ln(\mu e^3)$, where λ and μ are integers to be found.

(7)

June 2013 (R)

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3.   The curve C has equation

$$\cos 2x + \cos 3y = 1, \quad -\frac{\pi}{4} \le x \le \frac{\pi}{4}, \quad 0 \le y \le \frac{\pi}{6}.$$

(a) Find $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ in terms of x and y.

(3)

The point P lies on C where $x = \dfrac{\pi}{6}$.

(b) Find the value of y at P.

(3)

(c) Find the equation of the tangent to C at P, giving your answer in the form $ax + by + c\pi = 0$, where a, b and c are integers.

(3)

January 2010

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4.   Relative to a fixed origin O, the point A has position vector $\mathbf{i} - 3\mathbf{j} + 2\mathbf{k}$ and the point B has position vector $-2\mathbf{i} + 2\mathbf{j} - \mathbf{k}$. The points A and B lie on a straight line l.

(a) Find $\overrightarrow{AB}$.

(2)

(b) Find a vector equation of l.

(2)

The point C has position vector $2\mathbf{i} + p\mathbf{j} - 4\mathbf{k}$ with respect to O, where p is a constant.

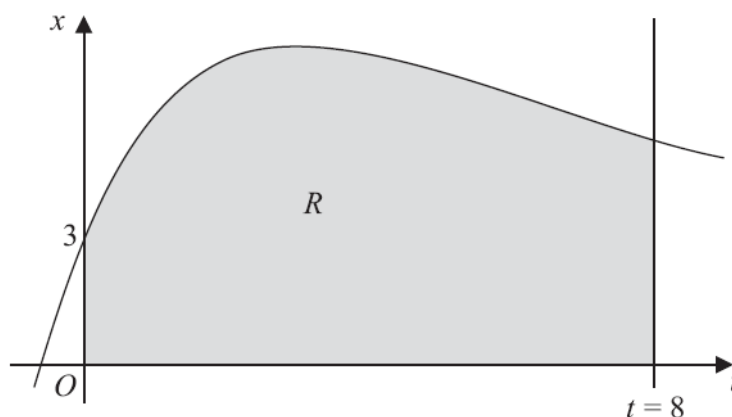Given that AC is perpendicular to l, find

(c) the value of p,

(4)

(d) the distance AC.

(2)

January 2011

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5.

Figure 1

Figure 1 shows part of the curve with equation $x = 4te^{-\frac{1}{3}t} + 3$. The finite region R shown shaded in Figure 1 is bounded by the curve, the x-axis, the t-axis and the line $t = 8$.

(*a*) Complete the table with the value of x corresponding to $t = 6$, giving your answer to 3 decimal places.

t	0	2	4	6	8
x	3	7.107	7.218		5.223

(1)

(*b*) Use the trapezium rule with all the values of x in the completed table to obtain an estimate for the area of the region R, giving your answer to 2 decimal places.

(3)

(*c*) Use calculus to find the exact value for the area of R.

(6)

(*d*) Find the difference between the values obtained in part (*b*) and part (*c*), giving your answer to 2 decimal places.

(1)

June 2013 (R)

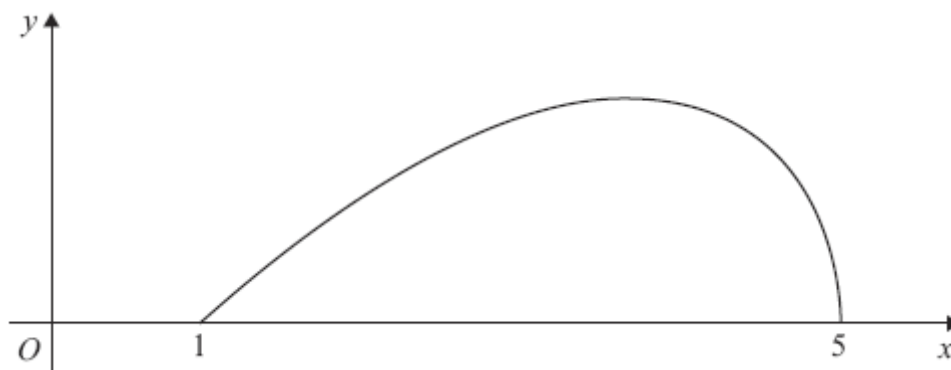**6.** (*a*) Find $\int \sqrt{(5-x)}\ dx$.

(2)

Figure 3

Figure 3 shows a sketch of the curve with equation

$$y = (x-1)\sqrt{(5-x)}, \quad 1 \le x \le 5$$

(*b*) (i) Using integration by parts, or otherwise, find $\int (x-1)\sqrt{(5-x)}\ dx$.

(4)

(ii) Hence find $\int_1^5 (x-1)\sqrt{(5-x)}\ dx$..

(2)

June 2009

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7. With respect to a fixed origin O, the lines l_1 and l_2 are given by the equations

$$l_1 : \mathbf{r} = (9\mathbf{i} + 13\mathbf{j} - 3\mathbf{k}) + \lambda(\mathbf{i} + 4\mathbf{j} - 2\mathbf{k})$$

$$l_2 : \mathbf{r} = (2\mathbf{i} - \mathbf{j} + \mathbf{k}) + \mu(2\mathbf{i} + \mathbf{j} + \mathbf{k})$$

where λ and μ are scalar parameters.

(*a*) Given that l_1 and l_2 meet, find the position vector of their point of intersection.

(5)

(*b*) Find the acute angle between l_1 and l_2, giving your answer in degrees to 1 decimal place.

(3)

Given that the point A has position vector $4\mathbf{i} + 16\mathbf{j} - 3\mathbf{k}$ and that the point P lies on l_1 such that AP is perpendicular to l_1,

(*c*) find the exact coordinates of P.

(5)

January 2013

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8. Relative to a fixed origin O, the point A has position vector $(10\mathbf{i} + 2\mathbf{j} + 3\mathbf{k})$, and the point B has position vector $(8\mathbf{i} + 3\mathbf{j} + 4\mathbf{k})$.

The line l passes through the points A and B.

(*a*) Find the vector $\overrightarrow{AB}$.

(2)

(*b*) Find a vector equation for the line l.

(2)

The point C has position vector $(3\mathbf{i} + 12\mathbf{j} + 3\mathbf{k})$.

The point P lies on l. Given that the vector $\overrightarrow{CP}$ is perpendicular to l,

(*c*) find the position vector of the point P.

(6)

June 2012

TOTAL FOR PAPER: 75 MARKS

END

Question Number	Scheme						Marks
1. (a)	x	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	$\frac{3\pi}{4}$	π	
	y	0	1.84432133 2...	4.81047738 1...	8.87207	0	

awrt 1.84432   B1

awrt 4.81048 or 4.81047   B1

[2]

0 can be implied

For structure of <u>trapezium rule</u> {...........} ;   M1 √

Correct expression <u>inside brackets</u> which all must be multiplied by their "outside constant".   A1 √

$= \dfrac{\pi}{8} \times 31.05374... = 12.19477518... = \underline{12.1948}$ (4 dp)

12.1948   A1 **cao**

[4]

6 marks

2.	$3^{x-1} + xy - y^2 + 5 = 0$	

$3^{x-1} \rightarrow 3^{x-1} \ln 3$ B1 oe

$\left\{ \dfrac{\cancel{dy}}{\cancel{dx}} \times \right\}$ $3^{x-1} \ln 3 + \left(y + x\dfrac{dy}{dx} \right) - 2y\dfrac{dy}{dx} = 0$

(ignore)

Differentiates implicitly to include either $\pm \lambda x\dfrac{dy}{dx}$ or $\pm ky\dfrac{dy}{dx}$.   M1*

$xy \rightarrow + y + x\dfrac{dy}{dx}$ B1

$... + y + x\dfrac{dy}{dx} - 2y\dfrac{dy}{dx} = 0$ A1

$\left\{ (1, 3) \Rightarrow \right\} 3^{(1-1)} \ln 3 + 3 + (1)\dfrac{dy}{dx} - 2(3)\dfrac{dy}{dx} = 0$

Substitutes $x = 1$, $y = 3$ into their differentiated equation or expression.   dM1*

$\ln 3 + 3 + \dfrac{dy}{dx} - 6\dfrac{dy}{dx} = 0 \Rightarrow 3 + \ln 3 = 5\dfrac{dy}{dx}$

$\dfrac{dy}{dx} = \dfrac{3 + \ln 3}{5}$ dM1*

$\dfrac{dy}{dx} = \dfrac{1}{5}\left(\ln e^3 + \ln 3 \right) = \dfrac{1}{5}\ln\left(3e^3 \right)$

Uses $3 = \ln e^3$ to achieve $\dfrac{dy}{dx} = \dfrac{1}{5}\ln\left(3e^3 \right)$ A1 **cso**

[7]

Question Number	Scheme	Marks
Q3	(a) $-2\sin 2x - 3\sin 3y \dfrac{dy}{dx} = 0$	M1 A1
	$\quad\quad\quad \dfrac{dy}{dx} = -\dfrac{2\sin 2x}{3\sin 3y}$ $\quad\quad$ Accept $\dfrac{2\sin 2x}{-3\sin 3y}$,	A1 (3)
	$\dfrac{-2\sin 2x}{3\sin 3y}$	
	(b) At $x = \dfrac{\pi}{6}$, $\quad\quad \cos\left(\dfrac{2\pi}{6}\right) + \cos 3y = 1$	M1
	$\quad\quad\quad\quad\quad \cos 3y = \dfrac{1}{2}$	A1
	$\quad\quad\quad 3y = \dfrac{\pi}{3} \Rightarrow y = \dfrac{\pi}{9}$	A1 (3)
	awrt 0.349	
	(c) At $\left(\dfrac{\pi}{6}, \dfrac{\pi}{9}\right)$, $\quad \dfrac{dy}{dx} = -\dfrac{2\sin 2\left(\frac{\pi}{6}\right)}{3\sin 3\left(\frac{\pi}{9}\right)} = -\dfrac{2\sin\frac{\pi}{3}}{3\sin\frac{\pi}{3}} = -\dfrac{2}{3}$	M1
	$\quad\quad\quad y - \dfrac{\pi}{9} = -\dfrac{2}{3}\left(x - \dfrac{\pi}{6}\right)$	M1
	Leading to $\quad\quad 6x + 9y - 2\pi = 0$	A1 (3)
		[9]

Question Number	Scheme	Marks
4. (a)	$\overrightarrow{AB} = -2\mathbf{i} + 2\mathbf{j} - \mathbf{k} - \left(\mathbf{i} - 3\mathbf{j} + 2\mathbf{k} \right) = -3\mathbf{i} + 5\mathbf{j} - 3\mathbf{k}$	M1 A1 (2)
(b)	$\mathbf{r} = \mathbf{i} - 3\mathbf{j} + 2\mathbf{k} + \lambda\left(-3\mathbf{i} + 5\mathbf{j} - 3\mathbf{k} \right)$ or $\mathbf{r} = -2\mathbf{i} + 2\mathbf{j} - \mathbf{k} + \lambda\left(-3\mathbf{i} + 5\mathbf{j} - 3\mathbf{k} \right)$	M1 A1ft (2)
(c)	$\overrightarrow{AC} = 2\mathbf{i} + p\mathbf{j} - 4\mathbf{k} - \left(\mathbf{i} - 3\mathbf{j} + 2\mathbf{k} \right)$ $= \mathbf{i} + \left(p + 3 \right)\mathbf{j} - 6\mathbf{k}$ or $\overrightarrow{CA}$	B1
	$\overrightarrow{AC}.\overrightarrow{AB} = \begin{pmatrix} 1 \\ p+3 \\ -6 \end{pmatrix}.\begin{pmatrix} -3 \\ 5 \\ -3 \end{pmatrix} = 0$	M1
	$-3 + 5p + 15 + 18 = 0$ Leading to $p = -6$	M1 A1 (4)
(d)	$AC^2 = \left(2 - 1 \right)^2 + \left(-6 + 3 \right)^2 + \left(-4 - 2 \right)^2$ $\left(= 46 \right)$	M1
	$AC = \sqrt{46}$ accept awrt 6.8	A1
		(2)
		[10]

Question Number	Scheme	Marks
5. (a)	$6.248046798... = 6.248$ (3dp) 6.248 or awrt 6.248	B1 **(1)**
(b)	Area $\approx \dfrac{1}{2} \times 2 \; ; \times \left[3 + 2(7.107 + 7.218 + \text{their } 6.248) + 5.22 \right.$	B1; M1
	$= 49.369 = 49.37 \,(2\text{ dp})$ 49.37 or awrt 49.37	A1 **(3)**
(c)	$\left\{ \displaystyle\int (4t\,e^{-\frac{1}{3}t} + 3)\, dt \right\} = -12t\,e^{-\frac{1}{3}t} - \displaystyle\int -12e^{-\frac{1}{3}t} \{dt\}$ $\pm At\,e^{-\frac{1}{3}t} \pm B\displaystyle\int e^{-\frac{1}{3}t}\{dt\}$, $A \neq 0$,	M1
		A1
	$+ 3t$ $3 \to 3t$	B1
	$= -12t\,e^{-\frac{1}{3}t} - 36e^{-\frac{1}{3}t} \{+ 3t\}$ $-12t\,e^{-\frac{1}{3}t} - 36e^{-\frac{1}{3}t}$	A1
	$\left[-12t\,e^{-\frac{1}{3}t} - 36e^{-\frac{1}{3}t} + 3t \right]_0^8 =$	
	$= \left(-12(8)\,e^{-\frac{1}{3}(8)} - 36e^{-\frac{1}{3}(8)} + 3(8) \right) - \left(-12(0)\,e^{-\frac{1}{3}(0)} - 36e^{-\frac{1}{3}(0)} + \right.$ Substitutes limits of 8 and 0 into an integrated function of the form of either $\pm\lambda t\,e^{-\frac{1}{3}t} \pm \mu\,e^{-\frac{1}{3}t}$ or $\pm\lambda t\,e^{-\frac{1}{3}t} \pm \mu\,e^{-\frac{1}{3}t} +$ and subtracts the correct way round.	dM1
	$= \left(-96e^{-\frac{8}{3}} - 36e^{-\frac{8}{3}} + 24 \right) - \left(0 - 36 + 0 \right)$	
	$= 60 - 132e^{-\frac{8}{3}}$ $60 - 132e^{-\frac{8}{3}}$	A1 **(6)**
(d)	Difference $= \left| 60 - 132e^{-\frac{8}{3}} - 49.37 \right| = 1.458184439... = 1.46 \,(2\text{ dp})$ 1.46 or awrt 1.46	B1 **(1)** **[11]**

Qn	Scheme	Marks
6. (a)	$\int \sqrt{(5-x)}\,dx = \int (5-x)^{\frac{1}{2}}\,dx = \dfrac{(5-x)^{\frac{3}{2}}}{-\frac{3}{2}} \quad (+C)$	M1 A1 (2)
	$\left(= -\dfrac{2}{3}(5-x)^{\frac{3}{2}} + C \right)$	
(b)(i)	$\int (x-1)\sqrt{(5-x)}\,dx = -\dfrac{2}{3}(x-1)(5-x)^{\frac{3}{2}} + \dfrac{2}{3}\int (5-x)^{\frac{3}{2}}\,dx$	M1 A1ft
	$= \qquad \ldots \qquad + \dfrac{2}{3} \times \dfrac{(5-x)^{\frac{5}{2}}}{-\frac{5}{2}} \quad (+C)$	M1
	$= -\dfrac{2}{3}(x-1)(5-x)^{\frac{3}{2}} - \dfrac{4}{15}(5-x)^{\frac{5}{2}} \quad (+C)$	A1 (4)
(ii)	$\left[-\dfrac{2}{3}(x-1)(5-x)^{\frac{3}{2}} - \dfrac{4}{15}(5-x)^{\frac{5}{2}} \right]_1^5 = (0-0) - \left(0 - \dfrac{4}{15} \times 4^{\frac{5}{2}} \right)$	
	$= \dfrac{128}{15}\left(= 8\dfrac{8}{15} \approx 8.53 \right) \qquad \text{awrt } 8.53$	M1 A1 (2)
		(8 marks)

11

Question Number	Scheme		Marks
7. (a)	**i:** $\quad 9 + \lambda = 2 + 2\mu$ **(1)** **j:** $\;13 + 4\lambda = -1 + \mu$ **(2)** **k:** $\;-3 - 2\lambda = \;1 + \mu$ **(3)**	Any two equations. (Allow one slip).	M1
	Eg: **(2)** – **(3)**: $16 + 6\lambda = -2$ or **(2)** – 4**(1)**: $-23 = -9 - 7\mu$	An attempt to eliminate one of the parameters.	M1
	Leading to $\lambda = -3$ or $\mu = 2$	Either $\lambda = -3$ or $\mu = 2$	A1
	$l_1 : \mathbf{r} = \begin{pmatrix} 9 \\ 13 \\ -3 \end{pmatrix} - 3\begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = \begin{pmatrix} 6 \\ 1 \\ 3 \end{pmatrix}$ or $l_2 : \mathbf{r} = \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} + 2\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} = \begin{pmatrix} 6 \\ 1 \\ 3 \end{pmatrix}$		M1 A1
			[5]
(b)	$\mathbf{d_1} = \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix}, \quad \mathbf{d_2} = \begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} \;\Rightarrow\; \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} \bullet \begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix}$	Realisation that the dot product is required between $\pm A\mathbf{d_1}$ and $\pm B\mathbf{d_2}$.	M1
	$\cos\theta = \pm\left(\dfrac{2 + 4 - 2}{\sqrt{(1)^2 + (4)^2 + (-2)^2} \cdot \sqrt{(2)^2 + (1)^2 + (1)^2}} \right)$	Correct **equation**.	A1
	$\cos\theta = \dfrac{4}{\sqrt{21}.\sqrt{6}} \;\Rightarrow\; \theta = 69.1238974... = 69.1 \text{ (1 dp)}$	awrt 69.1	A1
			[3]
(c)	$\overrightarrow{OA} = \begin{pmatrix} 4 \\ 16 \\ -3 \end{pmatrix}, \quad \overrightarrow{OP} = \begin{pmatrix} 9 \\ 13 \\ -3 \end{pmatrix} + \lambda\begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = \begin{pmatrix} 9 + \lambda \\ 13 + 4\lambda \\ -3 - 2\lambda \end{pmatrix}$		
	$\overrightarrow{AP} = \begin{pmatrix} 9 + \lambda \\ 13 + 4\lambda \\ -3 - 2\lambda \end{pmatrix} - \begin{pmatrix} 4 \\ 16 \\ -3 \end{pmatrix} = \begin{pmatrix} \lambda + 5 \\ 4\lambda - 3 \\ -2\lambda \end{pmatrix}$		M1 A1
	$\overrightarrow{AP} \bullet \mathbf{d_1} = 0 \;\Rightarrow\; \begin{pmatrix} \lambda + 5 \\ 4\lambda - 3 \\ -2\lambda \end{pmatrix} \bullet \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = \lambda + 5 + 16\lambda - 12 + 4\lambda = 0$		M1
	leading to $\{21\lambda - 7 = 0 \;\Rightarrow\}\; \lambda = \dfrac{1}{3}$	$\lambda = \dfrac{1}{3}$	A1
	Position vector $\overrightarrow{OP} = \begin{pmatrix} 9 \\ 13 \\ -3 \end{pmatrix} + \dfrac{1}{3}\begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = \begin{pmatrix} 9\frac{1}{3} \\ 14\frac{1}{3} \\ -3\frac{2}{3} \end{pmatrix}$ or $\begin{pmatrix} \frac{28}{3} \\ \frac{43}{3} \\ -\frac{11}{3} \end{pmatrix}$		M1 A1
			[6] **14**

Question Number	Scheme	Marks
8. (a)	$\overrightarrow{AB} = \begin{pmatrix} 8 \\ 3 \\ 4 \end{pmatrix} - \begin{pmatrix} 10 \\ 2 \\ 3 \end{pmatrix} = \begin{pmatrix} -2 \\ 1 \\ 1 \end{pmatrix}$	M1 A1 **(2)**
(b)	$\mathbf{r} = \begin{pmatrix} 10 \\ 2 \\ 3 \end{pmatrix} + t \begin{pmatrix} -2 \\ 1 \\ 1 \end{pmatrix}$ $\qquad\qquad$ $\mathbf{r} = \begin{pmatrix} 8 \\ 3 \\ 4 \end{pmatrix} + t \begin{pmatrix} -2 \\ 1 \\ 1 \end{pmatrix}$	M1 A1ft **(2)**
(c)	$\overrightarrow{CP} = \begin{pmatrix} 10 - 2t \\ 2 + t \\ 3 + t \end{pmatrix} - \begin{pmatrix} 3 \\ 12 \\ 3 \end{pmatrix} = \begin{pmatrix} 7 - 2t \\ t - 10 \\ t \end{pmatrix}$	M1 A1
	$\begin{pmatrix} 7 - 2t \\ t - 10 \\ t \end{pmatrix} . \begin{pmatrix} -2 \\ 1 \\ 1 \end{pmatrix} = -14 + 4t + t - 10 + t = 0$	M1
	Leading to $\qquad\qquad t = 4$	A1
	Position vector of P is $\begin{pmatrix} 10 - 8 \\ 2 + 4 \\ 3 + 4 \end{pmatrix} = \begin{pmatrix} 2 \\ 6 \\ 7 \end{pmatrix}$	M1 A1 **(6)**
		[10]

Question 1

A significant majority of candidates were able to score full marks on this question. In part (a), some candidates struggled to find either one or both of the y-ordinates required. A few of these candidates did not change their calculator to radian mode. In part (b), some candidates incorrectly stated the width of each of the trapezia as either $\frac{1}{4}$ or $\frac{\pi}{5}$. Nearly all answers were given to 4 decimal places as requested in the question.

Question 2

This question was generally well answered with about 62% of candidates gaining at least 6 of the 7 marks available and about 27% of candidates gaining all 7 marks.

Most candidates were able to differentiate implicitly but a significant minority struggled to differentiate 3^{x-1} and a few candidates did not apply the product rule correctly on xy. At this point a minority of candidates substituted $x = 1$ and $y = 3$ in their differentiated equation, but the majority of candidates proceeded to find an expression for $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ in terms of x and y, to give any equation of the form $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{y + 3^{x-1}\ln 3}{2y - x}$ before substituting in these values. Although the majority of candidates were able to write $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ as $\dfrac{3 + \ln 3}{5}$, most of them did not show sufficient working (i.e. writing 3 as $\ln \mathrm{e}^3$) in order to prove that this could be manipulated to give $\frac{1}{5}\ln(3\mathrm{e}^3)$.

Question 3

As has been noted in earlier reports, the quality of work in the topic of implicit differentiation has improved in recent years and many candidates successfully differentiated the equation and rearranged it to find $\dfrac{\mathrm{d}y}{\mathrm{d}x}$. Some, however, forgot to differentiate the constant. A not infrequent, error was candidates writing $\dfrac{\mathrm{d}y}{\mathrm{d}x} = -2\sin 2x - 3\sin 3y\dfrac{\mathrm{d}y}{\mathrm{d}x}$ and then incorporating the superfluous $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ on the left hand side of the equation into their answer. Errors like $\dfrac{\mathrm{d}}{\mathrm{d}y}(\cos 3y) = -\dfrac{1}{3}\sin 3y$ were also seen. Part (b) was very well done. A few candidates gave the answer $20°$, not recognising that the question required radians. Nearly all knew how to tackle part (c) although a few, as in Q2, spoilt otherwise completely correct solutions by not giving the answer in the form specified by the question.

Question 4

This question was well done and full marks were common. Part (a) was almost always correct and such errors as were seen were errors of arithmetic. Even at this level $2 - -3 = 1$ is seen from time to time. For (b), the majority knew the form of a straight line. A few got the vectors the wrong way round or produced an answer of the form $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$. The commonest error

was to give an answer of the form $\begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix} + \lambda \begin{pmatrix} -3 \\ 5 \\ -3 \end{pmatrix}$, not recognising that, as the question asks

for an equation, this expression must be preceded by $\mathbf{r} = \dots$.

Part (c) was more demanding and many were unable to choose vectors in the appropriate directions. Almost all knew that they had to form an equation by equating a scalar product to zero. However, often one of the position vectors was used; finding the scalar product of $\overrightarrow{OC}$ with $\overrightarrow{AB}$ being a common choice. Some formed the scalar product of $\overrightarrow{AB}$ with the vector equation of $\overrightarrow{AC}$ obtaining equations involving parameters as well as p. Almost all knew the appropriate method for part (d).

Question 5

This question was generally well answered although part (c) was found challenging by a number of candidates. About 56% of candidates gained at least 10 of the 12 marks available and about 23% of candidates gained all 12 marks.
In part (a), most candidates correctly computed 6.248 to 3 decimal places, but a few gave their answer to only 2 decimal places.
In applying the trapezium rule in part (b), a small minority of candidates multiplied $\frac{1}{2}$ by $\frac{8}{5}$ instead of $\frac{1}{2}$ by 2. Whilst the table of values clearly shows an interval width of 2, the application of a formula $h = \dfrac{b-a}{n}$ with $n = 5$ instead of $n = 4$ sometimes caused this error.
Other errors included the occasional bracketing mistake, use of the t-value of 0 rather than the ordinate of 3, and the occasional calculation error following a correctly written expression.
In part (c), a significant minority were only able to integrate 3 to give $3t$ but struggled to apply the correct strategy to integrate $4te^{-\frac{1}{3}}$ with respect to t. On the other hand, some candidates applied integration by parts correctly to give $-12te^{-\frac{1}{3}} - 36e^{-\frac{1}{3}}$ but then omitted the integration of 3 to give $3t$. A common error was $e^{-\frac{1}{3}t}$ being integrated to give $-\frac{1}{3}e^{-\frac{1}{3}t}$. There were a number of able students who, having integrated correctly, could not simplify their answer to give the exact value of $60 - 132e^{-\frac{8}{3}}$.
Most candidates who answered parts (b) and (c) correctly were able to find the correct difference of 1.46 in part (d), although a few found the percentage error of the estimate. Some candidates who had not answered part (c) correctly applied numerical integration in their calculator to give 50.828... and so were able to find the correct answer to part (d).

Question 6

Throughout this question sign errors were particularly common. In part (a), nearly all recognised that $(5-x)^{\frac{3}{2}}$ formed part of the answer, and this gained the method mark, but $\frac{3}{2}(5-x)^{\frac{3}{2}}$, $-\frac{3}{2}(5-x)^{\frac{3}{2}}$ and $\frac{2}{3}(5-x)^{\frac{3}{2}}$, instead of the correct $-\frac{2}{3}(5-x)^{\frac{3}{2}}$, were all frequently seen. Candidates who made these errors could still gain 3 out of the 4 marks in part (b)(i) if they proceeded correctly. Most candidates integrated by parts the "right way round" and were able to complete the question. Further sign errors were, however, common.

Question 7

In this question the majority of candidates were able to score full marks in Q7(a) and Q7(b).

Q7(a) was generally well answered, with most candidates gaining full marks. Having successfully found at least one of either μ or λ, some candidates proceeded no further and did not attempt to find the point of intersection. Some candidates used the third equation to prove that the two lines intersected, not realising that this was not required. Mistakes included minor errors in constructing the simultaneous equations or algebraic errors when solving their simultaneous equations.

In Q7(b), a large majority of candidates were able to find the correct acute angle by taking the dot product between the direction vectors of l_1 and l_2. The majority worked in degrees with only a few answers given in radians. Some candidates applied the dot product formula between multiples of the direction vectors (using their λ and μ from part (a)), which usually led to an obtuse angle; however, most realised that they needed to subtract this angle from $180°$ in order to find the correct acute angle. A number of candidates used incorrect vectors such as either $9\mathbf{i} + 13\mathbf{j} - 3\mathbf{k}$, $2\mathbf{i} - \mathbf{j} + \mathbf{k}$ or $6\mathbf{i} + \mathbf{j} + 3\mathbf{k}$ in their dot product equation.

The majority of candidates found Q7(c) challenging. To make progress with this question it is necessary to use the scalar product formula to obtain an equation in a single parameter, not the three unknowns x, y and z. So candidates who initially found the vector $\overrightarrow{AP}$ in terms of λ and who applied $\overrightarrow{AP} \bullet \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = 0$ were those who were more successful in gaining some or all of the 6 marks available. It was noticeable, however, that some of these candidates found incorrect values of λ such as 3 or even $-\dfrac{1}{3}$ following from a correct $21\lambda - 7 = 0$. It was also common to see a number of candidates who incorrectly tried to apply $\overrightarrow{OP} \bullet \overrightarrow{OA} = 0$ or $\overrightarrow{OP} \bullet \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = 0$ in order to find their λ. Candidates who found λ by a correct method were usually able to substitute it into the equation for l_1 in order to find the exact coordinates of P.

Question 8

In part (a), both marks were gained by nearly all candidates. Only a minority added the components or subtracted them the wrong way round. If $\overrightarrow{BA}$ was given instead of $\overrightarrow{AB}$, one mark was lost here but all other marks in the question could be gained. Again, in part (b), most candidates gained both marks but a substantial number of candidates failed to realise that the equation of a line must actually be an equation and, for example, omitted the "$\mathbf{r} =$" from $\mathbf{r} = \begin{pmatrix} 8 \\ 3 \\ 4 \end{pmatrix} + \lambda \begin{pmatrix} -2 \\ 1 \\ 1 \end{pmatrix}$.

Part (c) was very demanding and often proved to be an all or nothing affair. Correct methods were not often seen but, when they were, full marks were usually gained. Most knew that they should equate a scalar product to zero but the wrong vectors were often used. It would have helped candidates if they had drawn a diagram showing the points O, A, B, C and P. The scalar products $\overrightarrow{OP}.\overrightarrow{AB}$ or $\overrightarrow{OP}.\overrightarrow{OC}$ were often used instead of $\overrightarrow{CP}.\overrightarrow{AB}$. To make progress with this question it is necessary to use the correct scalar product to obtain an equation in a single parameter, not the three unknowns x, y and z. The most commonly seen successful method was to use the candidate's answer to (b) to obtain a vector expression for $\overrightarrow{CP}$ in terms of, say, λ. If the equation of the line is that given in the previous paragraph, this gives.

$$\overrightarrow{CP} = \begin{pmatrix} 5-2\lambda \\ \lambda-9 \\ \lambda+1 \end{pmatrix}$$. The scalar product of this vector with the answer to part (a) gives an equation

for λ. The value of the parameter given by this equation can then be substituted into the answer to part (b) to complete the question. There are alternative approaches to this question using differentiation or using the cosine rule to find the ratio, for example, $AB:AP$ but these were very rarely seen.

Statistics for C4 Practice Paper Bronze Level B4

Qu	Max score	Modal score	Mean %	ALL	A*	A	B	C	D	E	U
						Mean score for students achieving grade:					
1	6		84	5.04		5.60	5.06	4.37	3.94	3.20	2.06
2	7		75	5.25	6.62	5.79	5.00	3.89	3.19	2.21	0.71
3	9		75	6.71		7.91	6.70	5.71	4.08	2.79	1.74
4	10		70	6.97	9.76	8.14	6.33	4.56	3.16	2.77	1.64
5	11		69	7.57	10.25	8.39	6.69	5.18	4.39	3.52	2.15
6	8		65	5.16		6.79	5.42	4.02	2.86	1.83	0.98
7	14	8	62	8.70	13.31	10.54	7.96	5.85	4.48	3.27	1.47
8	10		50	4.98	9.12	5.93	4.35	3.51	2.95	2.32	1.53
	75		67	50.38		59.09	47.51	37.09	29.05	21.91	12.28